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POLAR RESEARCH IN THE BIOLOGICAL SCIENCES

Questionnaires were sent to 88 departments in 56 universities. Completed questionnaires were received from 52 departments in 39 universities. The responses from approximately two-thirds of the institutions represent more than one discipline in the biological sciences, i.e. each of these institutions is represented by one report from a department of biology, or two separate reports from departments of botany and zoology, or three separate reports from various combinations of departments of botany, zoology, physiology, forestry, bacteriology, entomology and limnology, and wildlife management. Several universities known to be active in polar research are not represented (e.g. California at Berkeley, Harvard, Oregon State, Pennsylvania State, and Tennessee).

Part I. Manpower

	Number of institutions / individuals	Comments
A. Professional level members now or formerly engaged in polar research. (Alaska 10, Michigan 8, Michigan State 6, Illinois 4, Mass. 4, Stanford 4; i.e. more than one-half of total is at 6 universities)	71	(10 institutions report having none)
B. Professional level members who could participate (includes those listed in category A). (Chicago 24, Kansas 21, Minnesota 11, MIT 19, Michigan State 13, Maryland 12, Michigan 12)	242	(2 institutions report having none)
C. Graduate students who are now or have been active in some form of polar research. C = 2.4% of D	46	(all in 16 institutions)
D. Total number of students working for higher degrees in reporting departments (includes 224 in "all biology departments" at Univ. of Maryland).	1917	
E. Students now working on theses related to polar areas.	20 Master's (9 at Alaska) 23 Ph. D.	
F. Theses related to polar areas completed during past 5 years.	17 Master's (10 at Alaska) 15 Ph. D. (5 at Illinois)	

Comment on manpower information:

Professional level members with polar research experience are strongly clustered in relatively few of the institutions, but this is not correlated with the sizes of the institutions (e.g. Alaska 10, Massachusetts 4). Only about one-third of the professional level members capable of participating have engaged in polar research, and (according to evaluations not available from the questionnaire) many of those who have, did so for relatively short period.

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The graduate students with experience in polar research (category C) are all at less than one-half of the institutions. Less than 2.4% of the total number of graduate students at the 37 institutions having graduate programs have experience in polar research.

The rate of production of theses based at least in part on polar research is increasing (items E and F) if the Master's degree is assumed to require about three years of study and the Ph. D. degree to require about five years. The rate of Ph. D. thesis production appears to be gaining over that of Master's thesis production.

Part II. Special facilities

	Number of institutions
No special facilities	15
Low temperature facilities	
Cold room facilities of wide range of types (excluding common deep-freeze equipment)	20
Within above category, facilities described as controlled environment chambers or rooms suitable for culture of cold climate organisms and experimentation. Cal. Tech., Chicago (includes biochemical facilities), Columbia (metabolic studies), Colorado (at Mountain Research Station and Tundra Lab.), Duke, Kansas State (especially psychrophilic organisms), MIT (includes 6 regrigerated centrifuges), Massachusetts, Michigan, Missouri (especially for frost effects on plants), VPI (cold incubators, low temperature Warburg apparatus, refrigerated centrifuges), Wyoming, Yale (including 2 systems of running sea water).	13
Zoological Collections, total	10
Vertebrates	
Colorado, Illinois (Ekblaw Coll.), Michigan State, Michigan, Stanford, Alaska	6
Marine organisms	
U.C.L.A., Stanford (marine station), Washington Univ. St. Louis, Yale	4
Botanical Collections, total	16
Herbaria	
Alaska (vascular plants and lichens). Duke, Iowa State (J. P. Anderson Coll.) Massachusetts (private coll. lower plants), Michigan State (Alaskan higher plants, lichens, fresh-water algae), Michigan (Alaskan, Canadian, Greenland higher plants, mosses, lichens, marine algae), Minnesota (Alaskan higher plants), Stanford (Alaskan higher plants, mosses) Wyoming (Alaskan, Rocky Mtn. alpine),	9

	Number of institutions
Botanical Collections (continued)	
Collections of fossil plants	
Michigan (Alaska), Minnesota, Washington Univ. St. Louis	3
Collections of living arctic and alpine plants	
Duke (vascular plants, coll. of viable seeds also), Michigan (wood-rotting fungi), Texas (airborne fungi), VPI (bacterial cultures)	4
Reference collections of pollen and spores (associated with pollen analytical laboratories)	
Michigan, Minnesota, Yale	3
Miscellaneous special facilities	
Alaska (arctic field equipment), Colorado (Mtn. Research Station and Tundra Lab.), Kansas State (equipment for air sampling of microorganisms), Michigan (lab and field equipment for limnology), Stanford (marine station equipment), Texas (coll. of airborne fungi), VPI (coll. of bacterial cultures), Washington Univ. St. Louis (radioisotope lab.)	8
Miscellaneous collections of importance to polar research	
Alaska (fishes, Brooks and Skinner collections of polar books), Bowdoin (museum of Peary and Macmillan items).	2
Library facilities:	
Institutions that omitted data on library facilities	2
Separate polar library (but not necessarily emphasizing biological sciences)	
Alaska (Brooks and Skinner collections)	1
Biological sciences departmental libraries making efforts to maintain polar research literature	6
Chicago, Columbia, Michigan, Ohio State, Stanford, Washigton	
General library housing only for whatever polar literature is held	25
Very limited library holdings of polar literature of any kind	5

Comment on special facilities information:

Many of the responding departments gave incomplete information and some gave none concerning special facilities, so this sample may be misleading with respect to the variety and number of various facilities

and their distributions. It is believed that pertinent zoological collections are particularly under-represented, and paleontological collections probably were reported under Geology whereas paleobotanical collections were reported on Biological Sciences questionnaires.

A considerable proportion of institutions reporting controlled environment facilities suitable for cold climate organisms are not using these for polar research.

Reports of collections of invertebrates are limited to those implied by "marine organisms" at four institutions. There is probably a serious deficiency in collections of fresh-water and terrestrial invertebrates.

Only one institution reports a collection of living arctic and alpine higher plants, but three report collections of living cultures of fungi and bacteria. A large proportion of the reporting institutions are known to possess greenhouse and growth chamber facilities suitable for cultivation of many species of arctic and alpine plants.

Only one institution, the University of Alaska, is situated in a climate of the polar type which would permit culture of arctic and alpine organisms without special provisions. Only one institution, the University of Colorado, has developed a permanent alpine laboratory.

The report on library facilities fails to indicate the special resources of polar literature at the various institutions, but does show that institutions strong in polar biological research do not maintain separate polar libraries for that research. Only 5 of the 39 reporting institutions considered their library holdings of polar literature very limited. This may reflect less need on the part of biologists for the older and scarcer works in polar literature.

Part III. Curriculum

	Number of institutions
No information furnished concerning curriculum	3
Offer no courses in which a major portion is given to polar biology	33
Two of these institutions plan to offer one course each (Stanford, seminar on antarctic marine biology, for graduate students; Syracuse, ecology of birds and mammals for graduate and undergraduate students).	
Offer courses which include a significant amount of material on polar biology	2
Duke (2 courses in physiological ecology and environmental ecology), Missouri (1 course in physiological response to environment, for undergraduates and graduate students)	

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Offer courses which include a significant amount of material on polar biology	3
(2 courses in ethological ecology and environmental zoology, Missouri)	
(1 course in physiological response to environment, for undergraduate and graduate students)	

	Number of institutions
Offer courses which are primarily oriented toward polar biology Alaska (10 courses, primarily in taxonomy, ecology, and wildlife, for undergraduates and graduate students)	1
Plan to offer courses in which polar biology will be emphasized Alaska (5 courses for undergraduate and graduate students), Stanford (1 seminar on antarctic marine biology, for graduate students), Syracuse (1 course on ecology of birds and mammals)	3

Comment on curriculum:

Students are introduced to and instructed in the biology of the polar regions only to a small extent through formal courses and seminars except at the University of Alaska. Little interest is expressed in changing this situation.

The number of courses with emphasis on polar organisms and environment that are offered by the University of Alaska suggest the advantage of location within or near polar areas for instruction. This correlation further suggests the desirability of extension of cooperation and support from other universities and agencies to the University of Alaska for increased volume of such instruction.

The sources of polar research experience for students were reported with various degrees of definiteness and overlap on the questionnaires. As near as could be determined, the cases reported are apportioned as follows:

Source of support or employment	Number of students
IGY	11
Arctic Institute of North America (includes some ONR-funded projects)	10
Residence at University of Alaska	9
Various projects sponsored by Federal Government	8
ONR	5
Active duty with Air Force	5
USARP	3
NSF	2
National Park Service	2
U. S. Geological Survey	1
U. S. Fish and Wildlife Service	1
Private expedition	1

Obviously students are introduced to and trained in polar research in the biological sciences primarily by holding junior positions on research projects, by obtaining research grants for independent work, by holding jobs with government agencies operating in polar regions, or by studying at the University of Alaska.

Part IV. Research Activities

	Number of institutions
A. No polar research in progress, no polar research contemplated	16
9 of these institutions indicate no past record of polar research activity	
1 of these institutions anticipates initiating a project	
B. One or more polar research projects in progress	23
7 of these institutions report only one project in progress.	
15 of these institutions indicate further research contemplated	
C. Some leading categories of biological research currently under study at the 23 institutions cited above:	
Zoology	
Mammals	2
Birds	5
Marine faunas, regional	5
Terrestrial faunas, regional	1
Wildlife problems	3
Basic animal physiology	2
Parasitology	1
Behavior studies	1
Botany	
Vascular plant floras, regional	3
Bryology	1
Algology	1
Mycology	2
Bacteriology	1
Basic plant physiology	2
Plant cytology	2
Paleobotany	2
Palynology	1
Ecology	
Limnology	3
Alpine animal ecology	1
Predator ecology	1
Regional plant ecology	3
Plant productivity	2
Soil-plant relationships	2
Vegetation in relation to glacial retreat	1

Comment on research activities:

The information in A above suggests that 7 institutions have discontinued polar research activity, and only one institution that has no research in progress contemplates initiation of such research. Of the 23 institutions with one or more research projects in progress, only 15 indicate that further research is contemplated. This situation implies that the number of institutions concerned with biological research related to polar regions is decreasing and may continue to decrease. Although the total level of activity measured in terms of support and personnel involved may be increasing, involvement of fewer institutions is likely to result in less diversity of research and less training of students.

The summary of research topic categories, although obviously arbitrary in the breakdown, points out considerable diversity of activity but a lack of attention to terrestrial invertebrates, fisheries problems, animal genetics and evolutionary processes, lower groups of animals (e.g. rotifers, nematodes), lichens, plant genetics and evolutionary processes, soil microbiology, and ecosystem studies. Although undoubtedly beingconsidered within many of these existing projects, biogeography and evolutionary aspects of adaptation do not appear to be given the emphasis that seems appropriate to a balanced program of polar biological research.

Part V. Recommendations

Recommendations returned on questionnaires:

Very few questionnaires contained comments on experiences with different types and sources of logistic support, and the comments that were made expressed general satisfaction except for one report of inadequate logistics by a U. S. military group, the difficulty being assigned to the inherent restrictions on military operations. Several references were made to need for greater latitude in arrangements for logistic support.

About one-half of the returned questionnaires carried comments on conditions for academic participation in polar biological research. The specific comments are summarized here; as follows:

Personnel:
- a. Too few people are interested in Arctic research.
- b. Support for graduate students throughout the year is needed.
- c. Researchers should take better advantage of opportunities for international cooperation in polar research.

Support:
- a. Support should be available to cover several seasons of field work and several years of data analysis to allow continuity of research.
- b. Support is needed for processing large bodies of existing data (e.g. meteorological records), and for supplying adequate aerial photographic coverage of study areas.
- c. Better support is needed for publication of lengthy and extensively illustrated monographs.

Facilities:
- a. More facility grants are needed for special equipment at home institutions, for field stations, and for mobile laboratories on land and at sea.
- b. More and better controlled low temperature environment facilities are needed.
- c. Funds and facilities are needed for more extensive floristic surveys in Alaska.

Research:
- a. Field research under winter conditions needs to be increased.
- b. Investigations of marine biology need to be extended in scope and areal coverage.
- c. Increased study of the physiology of tundra plants is needed.
- d. More and better studies of tundra plant productivity are needed.

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d. More and better studies of tundra ecosystems are needed.

General recommendations

1. More biologists need to be made aware of the opportunities offered by polar environments for studies of the physiology, adaptations, and evolutionary processes of organisms.

2. Greater advantage should be taken of the polar environment as a common ground for interdisciplinary cooperation in research, as between botanists and geomorphologists, zoologists and climatologists.

3. Professional personnel at more institutions should be encouraged and assisted in undertaking polar research, especially for the purpose of diversifying the research coverage and extending the number of students influenced by such research activity.

4. Encouragement should be provided to poorly represented areas of polar biological research, such as regional faunal and floristic studies, especially in more poorly known groups of organisms, biogeographical problems, problems in adaptation and evolution, and ecosystem ecology.

5. Support should be made available over periods sufficiently long to insure publication of a major part of accumulated data, to provide continuity to research by individuals, and to hold students to polar research problems in programs leading to higher degrees.

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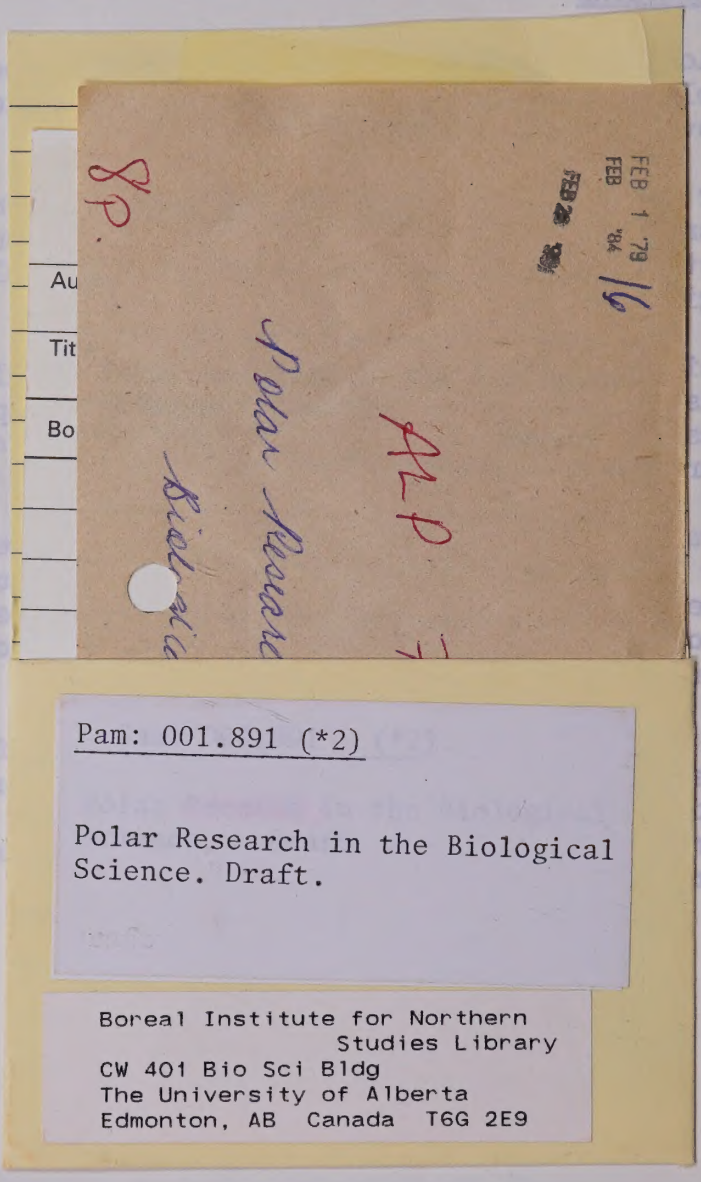

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Polar Research in the Biological Science. Draft.

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